Phase VI: Short-term Investigation of Groundwater Quality in the Pavillion, WY Area

February 2013

- Deliberative -

Contents

Project Planning Tasks

- Review Pavillion Gas Field data from DEQ, EPA, WOGCC, SEO, and BLM
- Identify data gaps and areas for potential additional investigation
- Further investigate the nature and extent of groundwater contamination within Areas of Interest (AOIs)
- Continued sampling of DWWs within Areas of Interest
- Project cost estimation

Assumptions & Considerations

- Please refer to slide 33 for costing assumptions that may impact cost estimate
- All work to be completed by outside contractors under the direction and oversight of DEQ
- All work shall comply with applicable statutory and regulatory requirements
- Procedures for well drilling, construction, installation, development, QA/QC, sampling and analysis shall be required and approved by DEQ prior to commencement of activities
- Monitor wells to be constructed of 2" stainless steel, minimum
- Assumed regional GW flow direction is generally to the Southeast; site specific GW flow direction may differ from regional flow as influenced locally by topography, irrigation activities & other surface water features
- Inventory of potential sources of contamination within 1000 feet of monitor well locations will be completed by DEQ
- Actual monitor well locations may differ from those proposed, based upon closer evaluation
- Production pit ranking (potential impacts to groundwater) were determined by review of Pit Working Group documentation
- Gas wells have been depicted on figures, however, additional field investigation is required to make a definitive identification of well name and location

Sources of Data

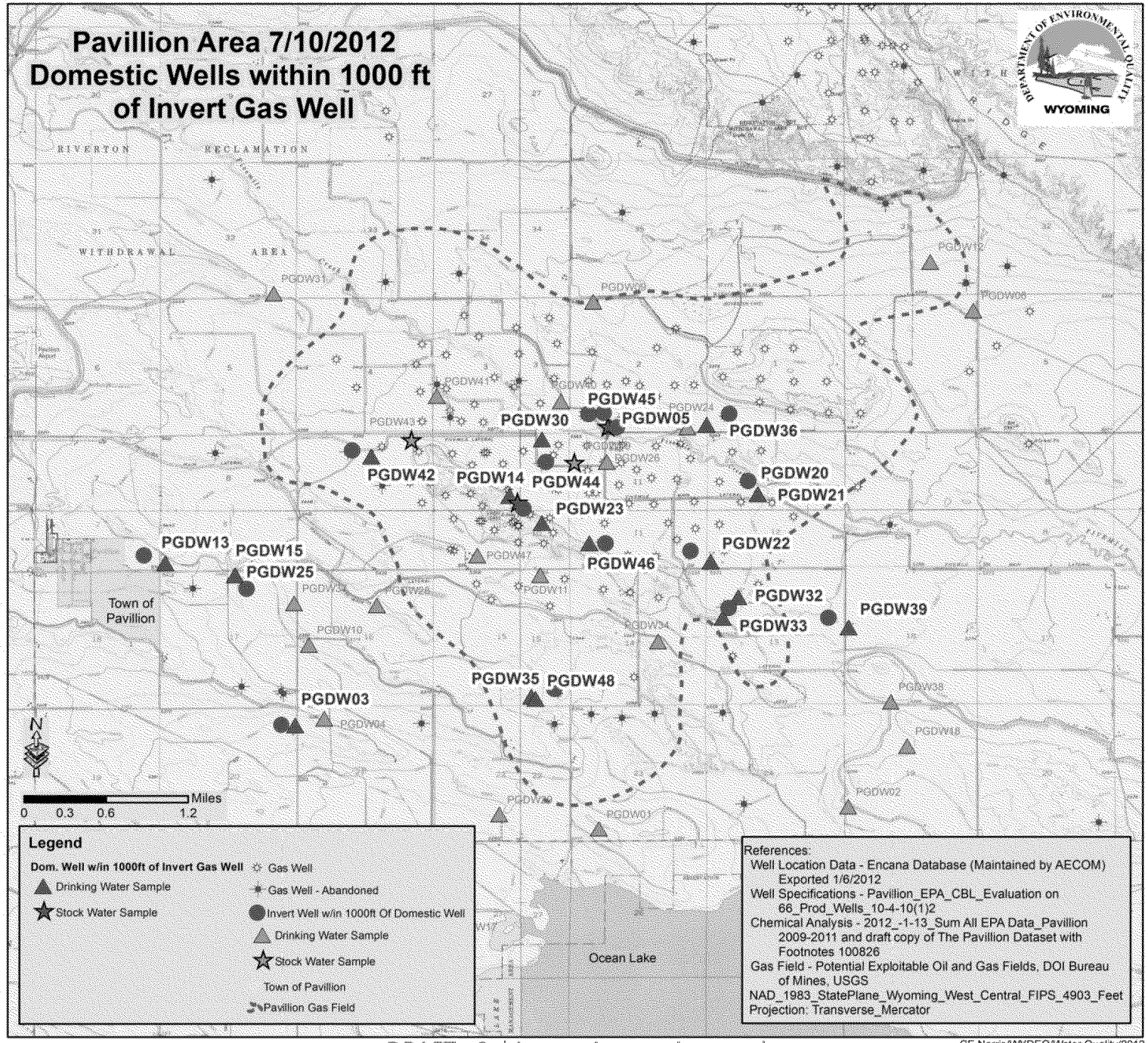
- WOGCC Bradenhead Test Data
- WOGCC Online Database
- Draft EPA Pavillion Report
- Pavillion Working Group Tables
- WDEQ GIS Figures (various data sources)
- WDEQ VRP and Tribal Pavillion files
- SEO e-Permit files
- SHWD Pavillion Landfill data

Project Objectives

- To further investigate groundwater quality within the limits of the Pavillion Study Area, and to attempt to identify potential sources of groundwater quality impacts to water supply wells.

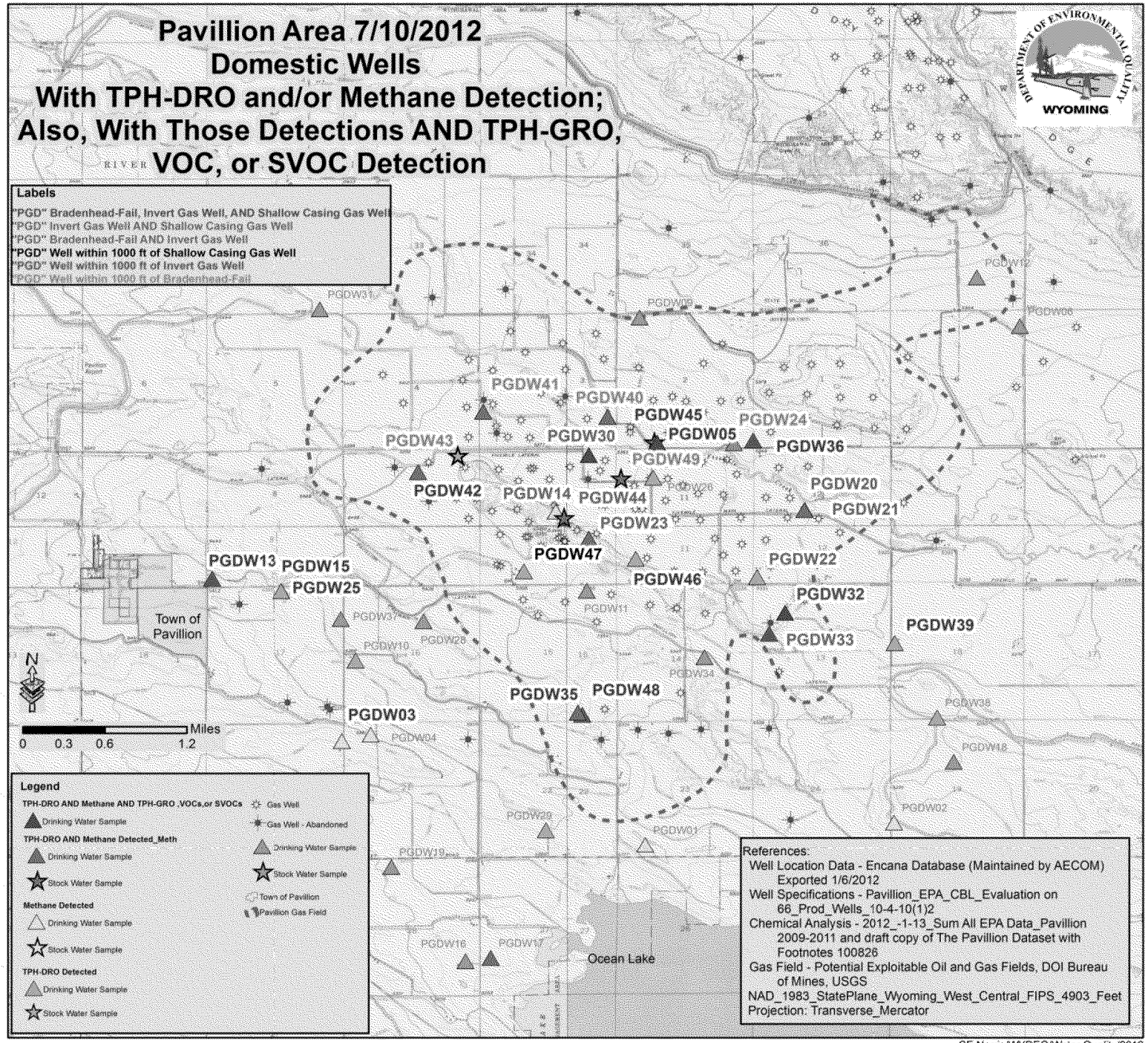
DWW Screening Criteria

- Is the Domestic Water Well (DWW) located within 1,000’ of an invert well?
  - Invert well: gas well drilled w/diesel-based drilling fluid
- Is the DWW w/in 1,000’ of a production pit?
- Is the DWW installed deeper than the surface casing w/in 1,000’ of nearby gas well(s)?
- Is the DWW w/in 1,000’ of a gas well where Bradenhead test showed pressure on the well annulus?
- Did the DWW exhibit the presence of methane, TPH-DRO/GRO, VOCs and/or SVOCs?



DRAFT - Subject to Agency Approval

CE Norris/WYDEQ/Water Quality/2012



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DWW Screening Results

- Six Locations Met the Screening Criteria
  - AOI #1: (b)(6) privacy [Landowner name] Area
  - AOI #2: (b)(6) privacy [Landowner name]
  - AOI #3: (b)(6) privacy [Landowner name] Area
  - AOI #4: (b)(6) privacy [Landowner name]
  - AOI #5: (b)(6) privacy [Landowner name]
  - AOI #6: (b)(6) privacy [Landowner name]

EPAPAV0030331

INVESTIGATION PLAN FOR AOIs

INVESTIGATION PLAN FOR AOIs

DOMESTIC WELLS

1. Down hole camera of DWWs to verify screened intervals
2. Sample domestic water wells within AOI for a minimum of two events prior to installation of monitoring wells
3. Conduct survey of land uses for other potential sources during DWW sampling in AOIs
4. All DWWs sampled for VOCs, SVOCs, TPH-DRO and DRO with silica gel cleanup, TPH-GRO, and Lead
5. Collect Field Parameters (pH, SpC, ORP, Temp, Turbidity, TDS, Salinity)
6. Conduct QAQC analysis on data
7. Review results prior to installation of monitoring wells

MONITORING WELLS

8. Conduct hydrophysical testing on wells to determine stratigraphic flow-regimes and use data to determine placement of well screened intervals
9. Initial sampling of monitoring wells for TPH-GRO/DRO, DRO with silica gel cleanup, VOCs, SVOCs, metals, and field parameters
10. Semi-annual sampling of constituents of concern based on initial sampling results
11. Semi-annual sampling of monitoring wells at same time as DWWs
12. Gas mudlogging of MW installations, if applicable

POTENTIAL CONCERNS

13. Landowner access agreements for sampling of DWWs and and installation of MWs
14. Drilling method (sonic, mud rotary, air rotary) to select; potential for encountering methane; need for blow-out preventers.

AREA OF INTEREST #1:

(b)(6) privacy [Landowner name] AREA

(AOI #1: (b)(6) privacy [Landowner name] Area)

AOI #1: [redacted] Area

BACKGROUND INFORMATION

- DWWs Total Depths (TD): [redacted] well (PGDW 14) 190-ft bgs, [redacted] well (PGDW 23) 500 ft-bgs, [redacted] stock well (PGDW44) 750-ft bgs
- 32-10c (4,020' TD; 1,920' – 1,925' and 3,476' – 3484' perf zones; surface casing 8 5/8" to 626')
- 44-10 (5,200' TD; no perforation information; surface casing 8 5/8" to 625'; no cement information)
- 33x-10, invert well, (6,000' TD plug back to 5893'; 5,126' – 5,490' perf zone; surface casing 8 5/8" to 514')
- 32-10c and 44-10 failed Bradenhead test, 33x-10 passed
- Production Pits at 33x-10 (32-10 shared ?) and 42-10
- Invert well and production pits 33x-10 w/in 1,000 feet of [redacted] residences
- Methane detected in all three domestic wells, TPH-DRO detected in [redacted] stock well; [redacted] well not tested for TPH-DRO), Toluene and benzoic acid (j-flagged) detected in [redacted] in-law well

RECOMMENDATIONS

- Sample [redacted] and [redacted] In-law wells semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of three sets of wells, at minimum of four depths (approx 50 ft, 200 ft, 500 ft, and 750 ft)
- Sampling & monitoring of the proposed MW's (12 total wells)
- Further onsite investigation necessary to definitively locate & label all gas wells

Note: DWW ID Number in () is EPA identification for sampling.

AREA OF INTEREST #2:

(b)(6) privacy [Landowner name]

(AOI #2: (b)(6) privacy [Landowner name]

Figure AOI #2 (b) (6) privacy [Landowner name]

Proposed MW Locations
Assumed GW Flow Direction(s)
Assumed Gas Well Pad Location
(TP: Tribal Pavillion)
(S & A: Shoshone & Arapaho)

AOI #2: [redacted]

BACKGROUND

- DWW TD: [redacted] (PGDW05) 207-ft bgs, [redacted] irrigation (PGDW45) 100-ft bgs
- 14-2, invert well, (5,250’ TD; 3,767’- 4,962’ perf zone; surface casing depths 18” to 47’ and 8 5/8” to 599’)
- 13-2, invert well, (3,400’ TD; 2,811’- 3,040’perf zone; 8 ¾”surface casing to 404’)
- 24-02, invert well, (3,942’ TD; 1,538’ – 1,550’ and 3,874’-3,878’ perf zones; 9 7/8” surface casing to 562’)
- 13-2 Bradenhead test showed pressure on annulus, 14-2 and 24-02 passed
- Production pits at 13-2 and 14-2, no information on 24-02
- Invert wells and production pits within 1000 ft of [redacted] wells
- Pit 14-2 in VRP, but on hold, sampling data not submitted to VRP? Large gas flow was observed to pit. Drill cutting buried in reserve pit
- Methane and TPH-DRO detected in both [redacted] wells, TPH-GRO detected in [redacted] well (PGDW05)

RECOMMENDATIONS

- Sample [redacted] wells semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of two sets of wells, nested at minimum of three depths (~50 ft, ~200 ft, and ~300 ft) (6 total wells)

AREA OF INTEREST #3:

(b)(6) privacy [Landowner name] AREA

(AOI #3: (b)(6) privacy [Landowner name] Area)

AOI #3: [redacted] Area

BACKGROUND

- DWW TD: [redacted] stock (PGDW49) 50-ft bgs; [redacted] (PGDW30) 260-ft bgs
  - 41x-10, invert well, (5,047' TD; 3,825' – 4,855' perf zone, 8 5/8" casing to 619')
  - 41-10 (3,180' TD plug back to 3,165'; 1,618' – 3,152' perf zone, 7" casing to 534')
  - 41-10B (3,841 TD plug back to 3,475'; 1,792'-3,024' and 3,545'-3,614' perf zones; 7" casing to 640')
  - 42-10 (5,995' TD plug back to 5,932'; 5,403' – 5,476' perf zone; 8 5/8" casing to 626'), produces oil
  - 42-10B (5,605' TD; 1,890'-1,902' and 4,855'-4,859 perf zones; 7" casing to 621')
  - 31-10 (5,972' TD plug back to 5,675'; 3,335' – 4,689' perf zone; 8 5/8" casing to 598'), produces oil
  - Production pit at 42-10 drill cuttings disposed onsite. No pit investigation information for the 42-10 or 41-10 locations.
  - 41-10, 31-10, 42-10B Bradenhead tests showed pressure on the annulus, 41-10B and 41x-10 no Bradenhead test conducted, 42-10 "passed"
  - Invert well located within 1,000 ft of [redacted] and [redacted]
  - Methane and TPH-DRO detected in both wells, TPG-GRO and benzoic acid (j-flagged) detected in [redacted] well

RECOMMENDATIONS

- Verify if EPA MW01 can be utilized in sampling program
- Sample DWWs semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of one set of wells, nested at minimum of three depths (approx 50 ft, 260 ft, and 500 ft) (3 total wells)

AREA OF INTEREST #4:

(b)(6) privacy [Landowner name]

(AOI #4: (b)(6) privacy [Landowner name]


PF21-9
(b) (6) privacy
[Landowner name]
S & A 41-9
PF31-9
Location Unknown
Figure AOI #4 (b) (6) privacy [Landowner name]
Proposed MW Locations
Assumed GW Flow Direction(s)
Gas Well Pad Location
(PF: Pavillion Fee)
© 2012 Google
Image USDA Farm Service Agency
Google earth
Imagery Date: 7/4/2009
1994
Eye alt 12514 ft

AOI #4: [redacted]

BACKGROUND

- DWWs TD: [redacted](PGDW42) 200-ft bgs, [redacted]? (PGDW43) 100-ft bgs
- 21-9, invert well (5,304' TD; surface casing to 815'; no perf zone info), abandoned
- 31-9 (3,445' plug back to 3,350'; 2,313'-3,312' perf zone, 7" casing to 534'), produces small amount of oil
- 41-9 (5,200' TD; no perf zone information; 8 5/8" casing to 604'), produces small amount of oil
- 31-9 and 41-9 Bradenhead test passed
- Production pits at 21-9 and 31-9 being investigated
- Production pits and invert well within 1,000 ft of [redacted]
- Methane, benzene (j-flagged), napthalene (j-flagged), and phenol detected in 200' well (low level), TPH-DRO detected in both wells

RECOMMENDATIONS

- Sample DWWs semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of one set of wells, nested at minimum of four depths (approx 50 ft, 100 ft, 200 ft, and 300 ft) (4 total wells)

AREA OF INTEREST #5:

(b)(6) privacy [Landowner name]

(AOI #5: (b)(6) privacy [Landowner name]


N
TP 22-12
EPA MW-2
Five Mile Creek
(b) (6) privacy
[Landowner name]
(b) (6) privacy
[Landowner name]
TPF 13-12
PF 13-12W
PF 12-12
Figure AOI #5
Proposed MW Locations
Assumed GW Flow Direction(s)
Gas Well Pad Location
(TP: Tribal Pavillion)
(TPF: Tribal Pavillion Fee)
(PF: Pavillion Fee)
© 2012 Google
Image USDA Farm Service Agency
Google earth
Imagery Date: 7/4/2009
1994
Eye alt 8705 ft

AOI #5: [redacted]

BACKGROUND

- DWW TD: [redacted] (PGDW20), (PGDW21) both 460' (?), (LD02) 610'
- 22-12 , invert well, (5,200' TD; 3,510' - 4,998' perf zone; surface casing to 586')
- 13-12 (3,275' TD plugged back to 3,150'; 2,170' – 3,125' perf zone; surface casing to 327')
- 12-12 (3,955' TD; 1,964'-2,025' and 3,645'-3,862 perf zones; 7" casing to 635')
- 22-12, 13-12, and 12-12 "passed" Bradenhead tests
- Invert well and production pits located within 1,000 ft of [redacted] wells
- Methane detected in all three wells (low level), TPH-DRO detected in PGDW21 and LD02; BTEX (j-flagged) detected in LD02; 2-BEP and benzoic acid (j-flags) detected in PGDW20 and LD02; 1,2,4-TMB and 1,3,5-TMB (j-flags) detected in LD02

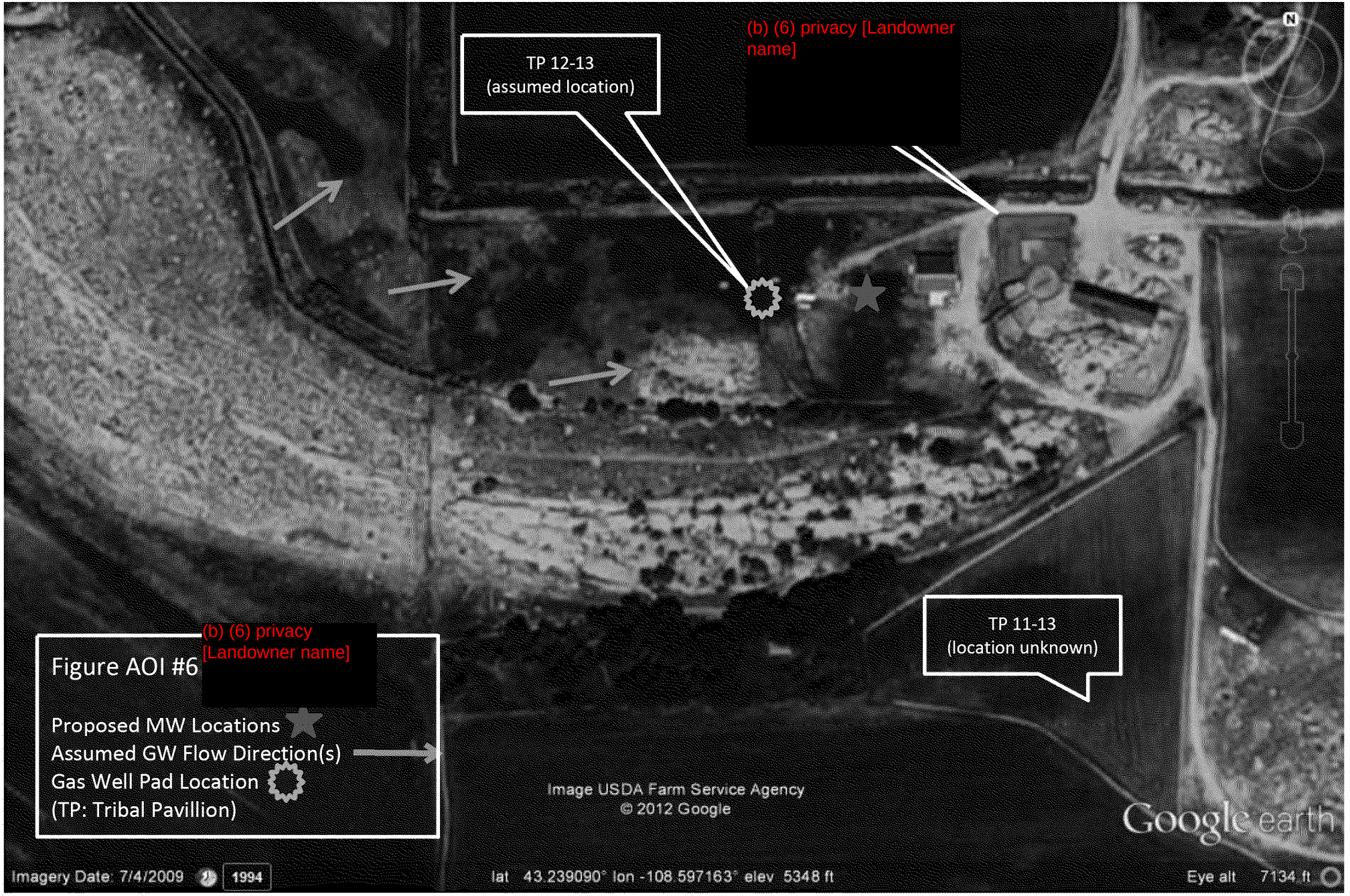
RECOMMENDATIONS

- Sample DWWs semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of two sets of wells, nested at minimum of four depths (approx 50 ft, 100 ft, 450 ft, and 650 ft) (8 total wells)

AREA OF INTEREST #6:

(b)(6) privacy [Landowner name]

(AOI #6: (b)(6) privacy [Landowner name]



AOI #6: [redacted]

BACKGROUND

- DWW TD: [redacted] (PGDW32) 674', [redacted] (PGDW33) 30', [redacted] (PGDW34) 100'
- 11-13 (5,500' TD; expired permit, no records)
- 12-13, abandoned (5,331' TD plugged back to 3,351'; 3,300' – 3,462' perf zone; surface casing to 576')
- Invert well and production pits located within 1,000 ft
- 12-13 Bradenhead test showed pressure on annulus, P&A'd in 2001
- Methane detected in PGDW32 and PGDW34 (PGDW33 not sampled), TPH-GRO and DRO detected in PGDW32 (PGDW33 and PGDW34 not sampled)

RECOMMENDATIONS

- Sample DWWs semi-annually (pre-irrigation time frame and during irrigation period)
- Installation of one set of wells, nested at minimum of four depths (approx 30 ft, 100 ft, and 675 ft)

SUMMARY OF ESTIMATED COSTS and TIMELINE

Costing Assumptions

- Contingency costs (e.g. inclement weather, etc.) have not been included
- Costs have been reasonably estimated but may differ considerably from actual costs
- Assumed that baseline groundwater sampling, and sampling after monitoring well installation would be conducted semi-annually. (Total of four sampling events)
- Assumes that monitoring well installation costs would be 2-inch wells, larger diameter wells for the deeper borings would result in increased cost.
- Assumes that all monitoring wells would be installed during the same mobilization of the drilling subcontractor. Also assumes that work will continue through the weekends.
- Costs were not included for blow-out prevention during installation of the monitoring wells.
- Investigation derived waste costs will be highly dependent on how much waste is generated, and where the waste can be disposed.
- Assumes all tasks, equipment, and subcontractors will be provided by/hired through the selected consultant.

Cost Summary

- Project Management
  $31,100
  - (Project Management; Develop HASP, QAPP, SAP; Property Access Agreements)
- Downhole Camera Private Drinking Water Wells
  $11,632
- Baseline Groundwater Sampling and Reporting $71,728
  - Semi-annual sampling (2 events) of 15 drinking water wells (DWWs)
- Monitoring Well Installation $2,437,951
- Investigation Derived Waste Disposal $60,000
- Groundwater Sampling of DWWs and MWs $212,966
  - (sampling 15 drinking water wells, 36 monitoring wells, and EPA MW01)
- Investigation Report
  $37,110
  - Summary of Baseline sampling, monitoring well installation, and investigation sampling
- Conduct Hydrogeophysical Testing on Deep Boreholes and Geophysical testing on all boreholes $130,000
- Gas Mudlogging $100,000

TOTAL **45 months** **$3,114,762**

Estimated Timeline

- 1st Quarter (Q1): Issue RFP
- Q2: Contract in Place
- Q2 – Q3: Baseline sampling of drinking water wells
- Q4: Monitor well installation
- 2Q2 – 2Q3: Sampling of monitoring wells
- 2Q4: Final report